ARGONNE NATIONAL LABORATORY
A U.S. Department of Energy laboratory operated by The University of Chicago

Process Evaluation Section

Process Evaluation section

TECHNOLOGY HIGHLIGHTS

Edward J. Daniels
Section Leader

Process Evaluation

Mission

- *The mission of the Process Evaluation Section at Argonne National Laboratory is to develop and/or assist in the development of commercially viable new processes for industry.*

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Representative Projects

Process Evaluation

- Materials Recovery from Shredder Residue
- Froth Flotation for Separation and Recovery of Thermoplastics
  - Appliances
  - Shredder Residue
  - Consumer Electronics
  - Industrial Scrap
- Recycling Aluminum Salt Cake
  - Electrodialysis for Salt/Flux Recovery
  - NMP Markets

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Representative Projects, cont'd.

Process Evaluation

- Recycling of Polymer Matrix Composites/PNGV
- SECAT
  - Reduction of Oxidative Melt Loss
  - Modeling and Optimization of Direct Chill Casting
  - Furnace Efficiency and Melt Practice
- Inert Anodes
  - Magnesium
  - Aluminum
- CFD Modeling
  - Simulation of a Novel Fluid Cat Cracker
  - Development and Validation of a Glass Furnace Model

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Technology Highlights

Process Evaluation

- Polyurethane foam recovery technology licensed to Salyp N.V. of Belgium---plans worldwide marketing of technology
- Section asked to lead PNGV Recycle Program
- Polyurethane foam technology wins R&D 100 award
- Strategic partnership formed with SECAT---3 new Aluminum IOF projects funded
- Nine recent patents issued
- FCC CFD code predicts 5% increase in gasoline yield---UOP and Chevron verifying results
- Plastics Recycling included as a topic in DOE SBIR/STTR FY 2000 solicitation---2 new projects
- Only laboratory led glass project
- Inert Anode LDRD leads to two projects

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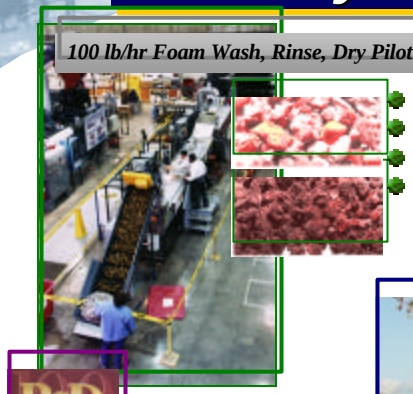
Polyurethane Foam Recovery from ASR

Process Evaluation



- Pilot-plant operation completed in 1998
- Technology licensed to Salyp N.V. in 2000
- Full-scale design completed 2001
- Full-scale plant installed 2002

Salyp ELV Center: Showcase for Argonne ASR Technology

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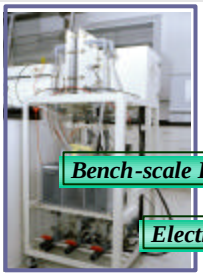
Recycling of Aluminum Salt Slags

Process Evaluation

Aluminum Melting Generates 1 million tpy of Salt Slags

- *Technology Assessment Completed in 1991*
  - *Low-cost Salt Flux Recovery*
  - *Markets for NMP*
- *Alumitech and Argonne Partner in 1996*
- *Alumitech confirms markets for NMP*
- *Argonne confirms technical and economic feasibility of electrodialysis for salt recovery*



Bench-scale ED Stack

Electrodialysis Pilot-Plant Completed Feb-2000

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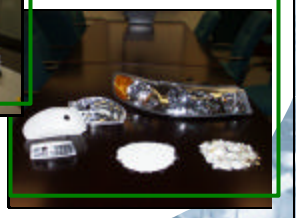
Thermoplastics Recovery via Froth Flotation

Process Evaluation

1000 lb/hr Froth Separation Unit

Injection mold tests confirm feasibility of 100% post consumer ABS for current applications



New projects will apply the basic technology to other source materials:

- *Consumer Electronics*
- *Industrial Scrap*
- *Shredder Residues*

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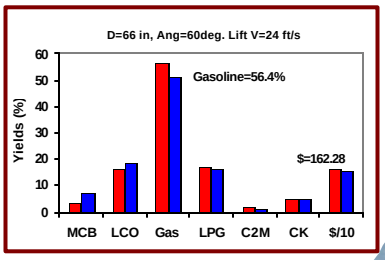
Computational Fluid Dynamics

Process Evaluation

Develop "State-of-the-Art" process models for evaluating opportunities to increase energy efficiency and productivity

- *Simulation Based on Copyrighted Multiphase Reacting Flow Code*
- *Current Projects*
  - *Catalytic Cracker (FCC)*
    Process Innovators
    UOP/Chevron
  - *Glass Furnace Modeling*
    Techniglas, Owens Corning, Libbey Inc., and OSRAM Sylvania



New Projects
Steel Blast Furnace---proposed
Aluminum Reverb Furnace---funded

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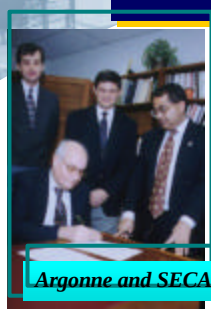
Partnerships

Process Evaluation



Argonne and SECAT sign MOU--- Jan. 2000

SECAT

Consortium for Aluminum Technology

ARCO Aluminum Inc.

HYDRO

IMCO

McCOOK METALS GROUP

wagstaff

LOGAN ALUMINUM

NSA
A Division of Southwire

COMMONWEALTH ALUMINUM

Three SECAT projects funded by Aluminum IOF

- *Reduction of Oxidative Melt Loss*
- *Reduction of Direct Chill Casting Ingot Cracking*
- *Improved Melt Practice*

R&D Team includes Argonne, ORNL, AlRC and UK

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Patents Issued

Process Evaluation

- Aluminum and Magnesium Melts
  - U.S Patent No. 6,485,541, *Method to Decrease Loss of Aluminum and Magnesium Melts*, Nov. 26, 2002, Hryn, Pellin, Calaway, Moore and Krumdick
- Electrodialysis Processing
  - U.S Patent No. 6,461,941, *Method and Apparatus for Electrodialysis Processing*, Oct. 8, 2002, Hryn, and Sreenivasarao
- Inert Anodes
  - U.S Patent No. 6,375,813, *Dimensionally Stable Anode for Electrolysis, Method for Maintaining Dimensions of Anode During Electrolysis*, April 23, 2002, Hryn, Pellin, Wolsky and Calaway
- Shredder Residue
  - U.S Patent No. 6,329,436, *Process to Recycle Shredder Residue*, Dec. 11, 2002, Jody, Daniels, and Bonsignore
- Inert Anodes
  - U.S Patent No. 6,083,362, *Dimensionally Stable Anode for Electrolysis, Method for Maintaining Dimensions of Anode During Electrolysis*, July 4, 2001, Hryn, Pellin, Wolsky and Calaway

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Patents Issued, cont'd.

Process Evaluation

- Cat Cracking
  - U.S Patent No. 6,013,172, *Methodology for Extracting Local Constants from Petroleum Cracking Flows*, Jan. 11, 2000, Chang, Lottes and Zhou
- Polyurethane Foam
  - U.S Patent No. 5,882,432, *Efficient Continuous Dryer for Flexible Polyurethane Foam and Cleaning Apparatus*, Mar. 16,1999, Jody, Daniels and Libera
- Dezinc
  - U.S Patent No. 5,779,878, *Process for Dezincing Galvanized Steel*, July 14, 1998, Morgan, Dudek and Daniels
- Froth Flotation
  - U.S Patent No. 5,653,867, *Method for the Separation of High Impact Polystyrene (HIPS) and Acrylonitrile Butadiene Styrene (ABS)*, Aug. 5, 1997, Jody, Arman, Karvelas, Pomykala and Daniels

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Copyrights

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- GFM - General Furnace Model Computer Code, version 2.0, ANL-IN-01-030, Computer Software Copyright, May, 2002
- GFM - General Furnace Model Computer Code, ANL-IN-01-030, Computer Software Copyright, May 14, 2001
- ICRKFLO2 - Three-Dimensional Multiple Phase Integral Petroleum Cracking Flow Computer Code, Computer Software Copyright, ANL-SF-97-082, September 1997
- ICOMFLO2 - Three-Dimensional Multiple Phase Integral Combustion Flow Computer Code, Computer Software Copyright, ANL-SF-93-109, September 11, 1995

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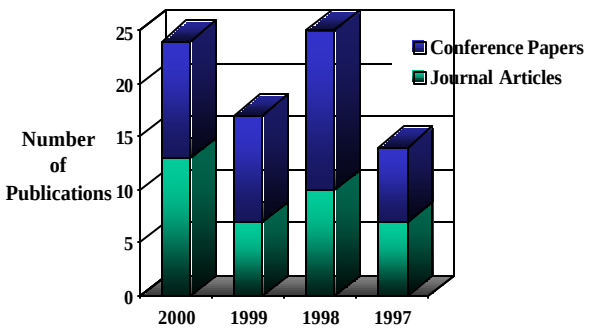
Publications Record

Process Evaluation



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Experimental Facilities

Process Evaluation

Bulk Physical Separation

Solvent Extraction

High-temperature Electro -chemical Separation

Hydrometallurgical Separation

Froth-Flotation/Density Separation

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Future

Process Evaluation

- Continue focus on process development---very applied RD&D
- Continue to establish strategic partnerships with industry to respond to OIT IOF program
  - Forest products
  - Steel
  - Mining
- Build on current experience base for other clients---WFO

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